FY 2013 Region 1 Refuge I&M Proposal

Submitted by: Malheur National Wildlife Refuge

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Project title: Developing Seasonal Spectral Signature Models to Accurately Assess Indicators of Aquatic Health: Algal Succession and Water Quality

Primary individual responsible for completing the project:
Linda Beck, Fish Biologist, contact information same as above.

Project abstract: Aquatic health is the number one issue to be addressed in the Malheur National Wildlife Refuge Comprehensive Conservation Plan. Malheur Lake is the number one priority area to address aquatic health. Therefore, baseline data are needed to track changes in aquatic health or determine success of future management actions. The purpose of this study is to develop models that correlate remotely sensed data to aquatic health. Pigments from chlorophyll *a* and various algal species impact the spectral signature of water bodies captured in remote imagery, such as LANDSAT and MODIS images. Technology has advanced such that the water quality parameters can be evaluated using a field validation technique. ARC GIS is used to construct a model, correlating spectral signature to aquatic health. Once the model is developed, past and future images can be evaluated spectrally to deduce the state of aquatic health over time. The new tool then can be used to establish aquatic health baseline, track trend, and determine success of management actions. Furthermore, this technique can be applied across this Refuge and the methodology can be used by others trying to evaluate water quality.

X	Inventory Project/Collection of Baseline Data	X	Adaptive Management
X	Data Compilation and Management	X	Protocol Development
☐	Purchase of Equipment	X	Evaluate effects of environmental stressors, incl. climate change
X	Leveraging existing programs supporting surveys on refuges.		

The Goal of the project is to produce a model allowing water quality in Malheur Lake to be evaluated using remotely-sensed data in a cost effective, timely manner.

Project objective(s):

1. Inventory water quality parameters (chlorophyll *a*, algae (species composition and biovolume), dissolved oxygen, turbidity, salinity, pH, conductivity, water temperature and depth) every 16 days from March to October in three fixed locations across Malheur Lake.
2. Determine genus/species and biovolume of algae blooms in Malheur Lake from each sampling time in Objective 1. There are seasonal variations in the algal population with

orange colors dominating in the spring and a transition to green in late summer to early fall.
3. Obtain LANDSAT 7 (Landsat Data Continuity Mission) scenes on every 16th day schedule starting in March to October. Transition to LANSAT 8 as it becomes available for ancillary use.
4. Determine spectral signature of unique seasonal algorithms based on pigmentation in order to benchmark, understand, and analyze water quality changes over time of Malheur Lake using Moderate-resolution Imaging Spectroradiometer (MODIS).
5. Create a protocol for project repeatability at other facilities.

Describe how project deliverable(s) will be used by the refuge staff for decision making:

Aquatic health was the number one issue determined in the CCP and Malheur Lake is the number 1 priority area of the CCP and Aquatic Health Plan. The working spectral signature model and associated ground truthed water quality data will be used to determine water quality changes over the late spring to early fall of 2013 and be the baseline for future management actions. The model will be applied to LANDSAT satellite imagery from the past (early 80's) to current day and every16 days into the future. The spectral signature model will be used to monitor water quality and determine management over time. This output will aid refuge staff to determine if management decisions to improve Malheur Lake aquatic health were successful by visually interpreting changes in water quality. For instance, if we remove 5000 carp from the water body and water quality improved than success was met. If no water quality changes occurred, it might be deduced that the management action of removing only 5000 carp was not enough or there is a secondary influence decreasing water quality in the Lake. Furthermore, Malheur Lake is a very dynamic terminal lake and water quality changes using past data will help model future water quality and aid management decisions on aquatic health.

Methods:

Objective 1. A YSI 6920 Multi-parameter Water Quality Sondes will be used to digitally collect dissolved oxygen, turbidity, salinity, pH, conductivity and temperature. Water depth will be collected via Robel pole. A GeoXM Trimble unit will collect GPS coordinates and a fence post will be pounded into the substrate and flagged to mark the repetitive collection site. The chlorophyll *a* and algal samples will be collected in a 500 ml Nalgene bottled from each site at 0.5 meters below the water surface. The chlorophyll *a* samples will be shipped over night on ice to Aquatic Research Inc. (http://www.aquaticresearchinc.com/). The algal samples will be overnighted to PhycoTech, Inc. (http://www.phycotech.com/products.html) for analysis.

Objective 2. The PhycoTech, Inc. laboratory under the direction of Dr. Ann St. Amand will identify the algal samples down to species and bio-volume will be calculated. Furthermore, a digital picture will be captured of the organisms and sent with the results.

Objective 3. Obtain LANDSAT data from the Global Visualization Viewer(www.glovis.usgs.gov). Each scene will be processed and archived in the Aquatic Health Geodatabase which is housed on the Malheur National Wildlife Refuge server.

Objective 4. Obtain MODIS data from the NASA Land Processes Distributed Active Archive Center (http://modis.gsfc.nasa.gov/data/). Each scene will be processed and archived in the Aquatic Health Geodatabase which is housed on the Malheur National Wildlife Refuge server. The data from objectives 1 – 4 will be processed together into a model.

Objective 4. Create a working protocol with steps for success of this type of modeling at other facilities.

Describe any statistical assistance, GIS, or database support needed: No statistical assistance will be needed. Assistance will be needed to perform the algal analysis by PhycoTech, Inc and chlorophyll *a* analysis by Aquatic Research Inc. GIS and database support will be contracted out to ensure that the objectives will be completed in the time allocated. Technical assistance will be provided by Dan Craver, USFWS RIB. The I&M program will be the repository for data and reports in the ServCat data base.

Project implementation timeline, including schedules for field/lab/office work, data management (entry, QA/QC, analyses, archiving), **and deliverables** (e.g., progress/final reports, potential peer-reviewed publications):

Remote imagery and water quality data will be collected between March and October, 2013. Water samples will be sent to laboratories within 24 hours of collection. Data management and data quality checks will occur concurrently.

Data analysis and spectral modeling will occur between October 15, 2013 and March 15, 2014. Final report, working model, GIS layer, archiving and metadata will be complete June 1, 2014.

Project Deliverables:
1. Developed Spectral Model that accurately assesses algal succession and water quality using remotely sensed data.
2. Establish lake-wide benchmark measures of water quality.
3. Developed protocol to track and monitor water quality using remotely sensed data based on algal succession.
4. Final report of findings submitted to ServCat.
5. Oral presentation at the North American Lake Management Society Annual Meeting
6. Published scientific peer-reviewed journal article.

Project completion date:
Mid Completion Date: October 31, 2013
Completion Date: June 2014.

Briefly describe how the project will address each of the following Evaluation Criteria:

1. **Planning Connection –** Malheur NWR Final CCP Goal 1. Is to enhance aquatic health and habitat conditions essential to the conservation of the flora and fauna that depend on Malheur Lake and associated water bodies. Objective 1a. focuses on Malheur and Mud Lakes. Strategies to fulfill this goal are 1.to collect data to understand the relationship among water chemistry and lake levels… 2. Develop a model to predict changes habitat response based upon biotic and abiotic factors… 3. Develop partnerships to address water quality… within the Harney Basin. Goal 13 is to gather scientific information to support adaptive management. Objectives 13a., 13d. 13e. Furthermore, in Appendix S, the Improving the Aquatic Health of Malheur NWR Strategy has determined that Malheur Lake is the priority area on the Refuge and that water quality data is an information need.
2. **Large Investment in Management Actions** – There are two full time employees (1 GS-11 and 1GS-4) who are dedicated to the aquatic health program. All staff from maintenance, fire, cultural resources, biology, visitor services and administration contribute to the aquatic health program. During the course of the year, we manage an average of 20 volunteers and six interns to gather baseline data or to conduct management actions to improve aquatic health along with collaborating with over 100 different entities. The spectral model will save the Refuge 32 hours of field work each month, increase safety to employees and will be the scientific documentation for baseline inventory prior to doing any carp control or management actions to improve aquatic health on Malheur Lake. Furthermore, we can analyze past imagery from rotenone treatments and flood events to determine trend data for natural and anthropogenic changes.
3. **Partners –** There are over 60 partners invested in the collaborative CCP process for the Refuge and want implementation of the plan that they helped create over the last 4 years. Specifically for this project, collaboration on the ground will occur between Refuge staff, USFWS-RIB, Division of Waters, ODFW and Ducks Unlimited and the GIS specialist hired to create the model.
4. **Controversy –** Implementation of our CCP is the highest priority for the Refuge and collaborators. Gathering baseline data prior to any management action, like killing large numbers of carp has been controversial because a percentage of our supporters want to see carcasses as a show of success. Therefore, we need to conduct this project within the next year and start implementing carp control to not only have carcasses but to be able to quantify any water quality changes associated with carp removal and management actions. By obtaining the baseline water quality first we will be using the best available science to determine success of any management action.
5. **National I&M Priority -** Direct/planned benefit to water quality/quantity, Direct/planned benefit to phenology, Direct/planned benefit to abiotic or biotic inventories
6. **Project Design –** see objective and methods listed above.
7. **Data Management (Complete the next section)**
8. **Continuity –** The model developed during this project can be used to estimate water quality from early 1980's into the future, by entering new LANDSAT and MODIS data into the model.

9. **Other Evaluation Criteria –** We are committed to publishing this project in a peer reviewed publication within 1 year of completion.

Briefly describe how the project will address each of the following elements of a Data management plan (See Appendix 1 in the RFP for definitions and examples):

- **Description**
  Data sources will be MODIS, LANDSAT, as well as all other ancillary data which will come from existing Refuge GIS Basedata Geodatabase. Water quality data will be a product of efforts by Malheur National Wildlife Refuge staff. The output data will be used at the landscape level but can have protocol replication potential for the National and Regional level.
- **Data Management Budget – Funding Requested for** GIS specialist – $17,600 and Laboratory Analysis – $20,009, In-Kind FWS data collection, equipment used - $22,938, all other collaborators will help with data collection and model interpretation. Estimated in-kind support ~ $22,000
- **Format –** Geodatabase – water quality data, MODIS, LANDSAT imagery.
- **Data Processing and Workflows –** All field data will be entered into the Trimble Unit or stored on the YSI unit. Field data will be downloaded and incorporated into the Aquatic_Health_Geodatabase daily. LANDSAT and MODIS information will be downloaded from the internet into the Aquatic_Health_Geodatabase.
- **Quality Checks –** Remote imagery will verify the Trimble GPS data is accurate. The YSI meter will be calibrated according to sampling protocol. All data will be computer generated so no typing errors will occur. Certified laboratories use standardized protocols and techniques and have internal QA/QC.
- **Back-up and Storage** -Data will be stored and backed up on a personal PC, Malheur NWR server and with Dan Craver at USFWS –RIB.
- **Metadata -** FGDC metadata standard will be used for all spatial data. Data creator, organization, contact information, as well as data abstract will all be included in metadata.
- **Restrictions** – No restrictions will be placed on this data or associated products.
- **Contact –** Linda Beck, Fish Biologist, Email - linda_beck@fws.gov

Budget for Developing Seasonal Spectral Signature Models to Accurately Assess Indicators of Aquatic Health: Algal Succession and Water Quality

				FY13		FY14	
	Item	Cost/ea	Quantity	Total Asking	In-Kind	Total Asking	In-Kind
Contracts							
PhycoTech Inc.	Algal Analysis (phytoplankton)	$329.00	51.00	$16,779.00			
Aquatic Research Inc.	Chlorophyll-A	$30.00	51.00	$1,530.00			
	Shipping	$50.00	34.00	$1,700.00			
Malheur Wildlife Associates	GIS Specialist	$22.00	800.00			$17,600.00	
Materials/Equipment							
	YSI Multiparameter Water Quality Sondes Meter				$12,000.00		
	Trimble GeoXM				$3,000.00		
	Nalgene Sampling Bottles	$4.00	102.00		$408.00		
FWS Personnel Costs	Fish Biologist	$50.00	120.00		$2,000.00		$4,000.00
	Fish Technician	$15.00	102.00		$1,530.00		
Totals				$20,009.00	$18,938.00	$17,600.00	$4,000.00
Total Funding Request	$37,609.00						
Total In-Kind	$22,938.00						
Total Project Cost	$60,547.00						